Serial No. 10/063,917 RD-28,965-1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Marc Schaepkens

Serial No.: 10/063,917 : Group Art Unit: 1775

Filed: May 23, 2002 : Examiner: Ling X. Xu

For: BARRIER LAYER FOR AN ARTICLE AND METHOD OF MAKING SAID BARRIER LAYER BY EXPANDING THERMAL PLASMA : Paper No.: 9

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APPELLANT'S BRIEF

This brief is in furtherance of the Notice of Appeal filed in this case on October 17, 2003.

If any additional fees for the accompanying response are required, Applicant requests that this be considered a petition therefor. The Director is hereby authorized to charge any fees that may be required to Deposit Account 07-0868.

This brief is transmitted in triplicate.

I. Real Party in Interest

The real party in interest is the General Electric Company, a corporation organized under the laws of the state of New York.

II. Related Appeals

There are no related appeals or interferences.

III. Status of Claims

Claims 1, 2, 4-22, 26-38, 40-56, and 60-107 remain in the case with none of the claims being allowed. A Restriction Requirement stated that Claims 1 and 79-124 are restricted as being directed to separate inventions. Group I, which includes Claims 1-25, is directed to a substrate. Group II, which includes Claims 26-59, is drawn to a barrier layer. Group III, which includes Claims 60-80, is directed to a method of making the substrate. Group IV, which includes Claims 81-103, is directed to a method of making another substrate. Claims 60-103 have been withdrawn. Claims 104-107 were added during prosecution. Claims 1, 2, 4-22, 26-38, 40-56, and 104-107 are on appeal.

IV. Status of Amendments

Two amendments, Paper No. 4, filed on July 17, 2003; and Paper No. 6, filed on September 15, 2003, after the Final Office Action of August 16, 2003, have been entered.

V. Summary of Invention

One embodiment of the disclosed invention provides an article. The article 100 (Figure 1) comprises a substrate 102 and at least one barrier layer 106 disposed on at least one surface of the substrate (Paragraph [0024]). Where substrate 102 is a polymeric material, substrate 102 comprises at least one of a polycarbonate, a polyethylene terephtalene, a polyethylene naphthalene, a polyimide, a polyethersulfone, a polyacrylate, a polynorbornene, and combinations thereof (Paragraph [0024]).

The barrier 106 layer comprises an inorganic material, and is resistant to transmission of moisture and oxygen therethrough. The barrier layer has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day (Paragraph [0024]). The at least one barrier layer 106 comprises at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, wherein the metal is one of silicon, aluminum, zinc, indium, tin, and a transition metal, such as, but not limited to, titanium (Paragraph [0025]).

Article 100 may further include at least one layer 110 (Figure 1), which is disposed adjacent to the at least one barrier layer 106 (Paragraph [0027]). Where article 100 is a LCD display (Figure 2), the at least one layer may include at least one transparent electrically conductive layer. Where article 100 is a light emitting diode (LED) (Figure 3a) or an organic electroluminescent device (OELD) (Figure 3b), the at least one layer may include, for example, a cathode layer, an electron transport layer, an emission layer (in OELDs), a hole transport layer, and an anode layer.

A second aspect of the invention is to provide a barrier layer 106 that is resistant to transmission of moisture and oxygen therethrough. The barrier layer comprises at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof. Each of the metal nitride, the metal carbide, and the metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof (Paragraph [0025]). The barrier layer 106 has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day(Paragraph [0025]).

A third aspect of the invention is to provide an article. The article comprises a substrate and at least one barrier layer, the at least one barrier layer comprising at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, wherein each of the metal nitride, the metal carbide, and the metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof, and wherein the barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day.

A fourth aspect of the invention is to provide a method of forming a coated article. The coated article comprises a substrate and a barrier layer disposed thereon, wherein the barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of

less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day. The method comprises the steps of: providing a substrate; generating a thermal plasma, the thermal plasma having an electron temperature of less than about 1eV; injecting at least one reagent into the thermal plasma; reacting the at least one reagent in the thermal plasma to form at least one deposition precursor; and depositing the at least one deposition precursor on the substrate at a rate of at least about 200 nm/min to form the barrier layer on the substrate.

A fifth aspect of the invention is to provide a method of forming a barrier layer on a substrate. The barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day, and comprises at least one of at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, wherein each of the metal nitride, the metal carbide, and the metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof. The method comprises the steps of: generating a thermal plasma, the thermal plasma having an electron temperature of less than about 1eV; injecting a first reagent into the thermal plasma, the first reagent comprising at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof; injecting a second reagent into the thermal plasma, the second reagent comprising at least one of oxygen, nitrogen, and ammonia; decomposing the first reagent and the second reagent in the thermal plasma to form a plurality of decomposition products; reacting the at least one reagent in the thermal plasma to form at least one deposition precursor; and depositing the at least one deposition precursor on the substrate at a rate of at least about 200 nm/min to form the barrier layer comprising at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof on the substrate.

A sixth aspect of the invention is to provide a method of forming a coated article. The coated article comprises a substrate and a barrier layer disposed thereon. The barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water

vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day, and comprises at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, wherein each of the metal nitride, the metal carbide, and the metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof. The method comprises the steps of: providing a substrate; generating a thermal plasma, the thermal plasma having an electron temperature of less than about 1eV; injecting a first reagent into the thermal plasma, the first reagent comprising at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof; injecting a second reagent into the thermal plasma, the second reagent comprising at least one of oxygen, nitrogen, and ammonia; reacting the first reagent and the second reagent in the thermal plasma to form at least one deposition precursor; and depositing the at least one deposition precursor on the substrate at a rate of at least about 200 nm/min, thereby forming the barrier layer comprising at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof on the substrate.

<u>A. Claim 1 and its dependent claims (Claims 2, 4-22, 104, and 105)</u>

Claim 1 recites an article comprising: a polymeric substrate comprising one of a polycarbonate, a polyimide, a polyethersulfone, a polynorborene, a polyethylene terephthalate, a polyethylene naphthalate, a polyacrylate, and combinations thereof; and a barrier layer disposed on at least one surface of the polymeric substrate, wherein the barrier layer comprises an inorganic material, and wherein the barrier layer has a thickness of less than 10,000 nm and is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day.

Claim 2 recites the article of Claim 1 and further includes at least one layer, wherein the at least one layer is disposed on a surface of the barrier layer opposite the

polymeric substrate, such the the barrier layer is interposed between the polymeric substrate and the at least one layer.

Claim 4 recites the article of Claim 1 and further includes at least one layer interposed between the barrier layer and the polymeric substrate.

Claim 5 recites the article of Claim 4, wherein the at least one layer comprises an adhesion layer for promoting adhesion of the barrier layer to the polymeric substrate.

Claim 6 recites the article of Claim 5, wherein the adhesion layer comprises at least one of: a metal in elemental form, a carbide, an oxycarbide, an oxide, and a nitride of the metal, wherein the metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, platinum, and combinations thereof.

Claim 7 recites the article of Claim 2, wherein the at least one layer comprises at least one of an abrasion resistant layer, an ultraviolet radiation-absorbing layer, an infrared radiation-reflecting layer, and an electrically conducting layer.

Claim 8 recites the article of Claim 7, wherein the abrasion resistant layer comprises at least one of: a carbide of a metal, an oxycarbide of the metal, an oxide of the metal, and a nitride of the metal, wherein the metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, platinum, and combinations thereof.

Claim 9 recites the article of Claim 7, wherein the ultraviolet radiation-absorbing layer comprises at least one of titanium oxide, zinc oxide, cerium oxide, a polymer, and combinations thereof.

Claim 10 recites the article of Claim 7, wherein the infrared radiation-reflecting layer comprises at least one of silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

Claim 11 recites the article of Claim 7, wherein the electrically conducting layer comprises at least one of silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

Claim 12 recites the article of Claim 1, wherein the inorganic material comprises at least one of an oxide, a nitride, and a carbide of a metal, and combinations thereof.

Claim 13 recites the article of Claim 12, wherein the metal is one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof.

Claim 14 recites the article of Claim 13, wherein the transition metal is titanium.

Claim 15 recites the article of Claim 13, wherein the inorganic material comprises titanium oxide.

Claim 16 recites the article of Claim 13, wherein the inorganic material comprises silicon nitride.

Claim 17 recites the article of Claim 1, wherein the barrier layer has a thickness in a range from about 10 nm to less than 10,000 nm.

Claim 18 recites the article of Claim 17, wherein the barrier layer has a thickness in a range from about 20 nm to about 500 nm.

Claim 19 recites the article of Claim 1, wherein the barrier layer has a water vapor transmission rate of up to about 0.2 g/m^2-day.

Claim 20 recites the article of Claim 1, wherein the barrier layer has an oxygen transmission rate at 25°C and 100% oxygen concentration of up to about 0.2 cc/m^2-day.

Claim 21 recites the article of Claim 1, wherein the article is one of a light emitting diode (LED), a liquid crystal display (LCD), a photovoltaic article, a flat panel display device, an electrochromic article, an organic integrated circuit, and an organic electroluminescent device (OELD).

Claim 22 recites the article of Claim 1, wherein the barrier layer is deposited on the polymeric substrate by: injecting at least one reagent into an expanding thermal plasma; reacting the at least one reagent in the expanding thermal plasma to form at least one deposition precursor; and depositing the at least one deposition precursor on the polymeric substrate at a rate of at least about 200 nm/min to form the barrier layer on the polymeric substrate.

Claim 104 recites the article of Claim 6, wherein the adhesion layer comprises at least one of: amorphous carbon; a ceramic material, wherein the ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; an epoxide; an acrylate; an acrylonitrile; a xylene; a styrene; and combinations thereof.

Claim 105 recites the article of Claim 8, wherein said abrasion resistant layer comprises at least one of: amorphous carbon; a ceramic material, wherein said ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; an epoxide; an acrylate; an acrylonitrile; a xylene; a styrene; polymerized monomers; polymerized oligomers; an organic polymer; an inorganic-organic polymer; and combinations thereof.

<u>B. Claim 26 and its dependent claims (Claims 27-36).</u>

Claim 26 recites a barrier layer deposited on a polymeric substrate. The polymeric substrate comprises one of a polycarbonate, a polyimide, a polyethersulfone, a polynorborene, a polyethylene terephthalate, a polyethylene naphthalate, a polyacrylate, and combinations thereof. The barrier layer has a thickness of less than 10,000 nm and comprises at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, and wherein each of the metal nitride, metal carbide, and metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof, and wherein the barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative

humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day.

Claim 27 recites the barrier layer of Claim 26, wherein the transition metal is titanium.

Claim 28 recites the barrier layer of Claim 26, wherein the barrier layer comprises titanium oxide.

Claim 29 recites the barrier layer of Claim 26, wherein the barrier layer comprises silicon nitride.

Claim 30 recites the barrier layer of Claim 26, wherein the barrier layer has a thickness in a range from about 10 nm to less than 10,000 nm.

Claim 31 recites the barrier layer of Claim 30, wherein the barrier layer has a thickness in a range from about 20 nm to about 500 nm.

Claim 32 recites the barrier layer of Claim 26, wherein the barrier layer has a water vapor transmission rate of up to about 0.2 g/m^2-day.

Claim 33 recites the barrier layer of Claim 26, wherein the barrier layer has an oxygen transmission rate at 25°C and 100% oxygen concentration of up to about 0.2 cc/m^2-day.

Claim 34 recites the barrier layer of Claim 26, wherein the barrier layer is deposited on the polymeric substrate by: injecting a first reagent into an expanding thermal plasma, the first reagent comprising at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof; injecting a second reagent into the expanding thermal plasma, the second reagent comprising at least one of oxygen, nitrogen, hydrogen, water, and ammonia; reacting the first reagent and the second reagent in the expanding thermal plasma to form at least one deposition precursor; and depositing the at least one deposition precursor on the polymeric substrate at a rate of at least about 200 nm/min to form the barrier layer on the polymeric substrate.

Claim 35 recites the barrier layer of Claim 34, wherein the at least one deposition precursor is deposited at a rate of at least about 600 nm/min to form the barrier layer on the polymeric substrate.

Claim 36 recites the barrier layer of Claim 34, wherein the at least one deposition precursor is deposited on the polymeric substrate at a rate of at least about 3,000 nm/min to form the barrier layer on the polymeric substrate.

C. Claim 37 and its dependent claims (Claims 38, 40-56, 106, and 107)

Claim 37 recites an article. The article comprises: a polymeric substrate comprising one of a polycarbonate, a polyimide, a polyethersulfone, a polynorborene, a polyethylene terephthalate, a polyethylene naphthalate, a polyacrylate, and combinations thereof; and a barrier layer, wherein the barrier layer has a thickness of less than 10,000 nm and comprises at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, wherein each of the metal nitride, the metal carbide, and the metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof, and wherein the barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day.

Claim 38 recites the article of Claim 37, further including at least one layer, wherein the at least one layer is disposed on a surface of the barrier layer opposite the polymeric substrate, such that the barrier layer is interposed between the polymeric substrate and the at least one layer.

Claim 40 recites the article of Claim 37, further including at least one layer interposed between the barrier layer and the polymeric substrate.

Claim 41 recites the article of Claim 40, wherein the at least one layer comprises an adhesion layer for promoting adhesion of the barrier layer to the polymeric substrate.

Claim 42 recites the article of Claim 41, wherein the adhesion layer comprises at least one of: a metal in elemental form, a carbide of the metal, an oxycarbide of the metal, an oxide of the metal, and a nitride of the metal, wherein the metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, platinum, and combinations thereof.

Claim 43 recites the article of Claim 38, wherein the at least one layer comprises at least one of an abrasion resistant layer, an ultraviolet radiation-absorbing layer, an infrared radiation-reflecting layer, and an electrically conducting layer.

Claim 44 recites the article of Claim 43, wherein the abrasion resistant layer comprises at least one of: a carbide of a metal, an oxycarbide of the metal, an oxide of the metal, and a nitride of the metal, wherein the metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, platinum, and combinations thereof.

Claim 45 recites the article of Claim 43, wherein the ultraviolet radiation-absorbing layer comprises at least one of titanium oxide, zinc oxide, cerium oxide, a polymer, and combinations thereof.

Claim 46 recites the article of Claim 43, wherein the infrared radiation-reflecting layer comprises silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

Claim 47 recites the article of Claim 43, wherein the electrically conducting layer comprises silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

Claim 48 recites the article of Claim 37, wherein the transition metal is titanium.

Claim 49 recites the article of Claim 48, wherein the barrier layer comprises titanium oxide.

Claim 50 recites the article of Claim 37, wherein the barrier layer comprises silicon nitride.

Claim 51 recites the article of Claim 37, wherein the barrier layer has a thickness in a range from about 10 nm to less than 10,000 nm.

Claim 52 recites the article of Claim 51, wherein the barrier layer has a thickness in a range from about 20 nm to about 500 nm.

Claim 53 recites the article of Claim 37, wherein the barrier layer has a water vapor transmission rate of up to about 0.2 g/m^2-day.

Claim 54 recites the article of Claim 37, wherein the barrier layer has an oxygen transmission rate at 25°C and 100% oxygen concentration of up to about 0.2 cc/m^2-day.

Claim 55 recites the article of Claim 37, wherein the article is one of a light emitting diode (LED), a liquid crystal display (LCD), a photovoltaic article, a flat panel display device, an electrochromic article, an organic integrated circuit, and an organic electroluminescent device (OELD).

Claim 56 recites the article of Claim 37, wherein the barrier layer is deposited on the polymeric substrate by: injecting a first reagent into an expanding thermal plasma, the first reagent comprising at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof; injecting a second reagent into the expanding thermal plasma, the second reagent comprising at least one of oxygen, nitrogen, and ammonia; reacting the first reagent and the second reagent in the expanding thermal plasma to form at least one deposition precursor; and depositing the at least one deposition precursor on the polymeric substrate at a rate of at least about 200 nm/min to form the barrier layer on the polymeric substrate.

Claim 106 recites the article of Claim 44, wherein the abrasion resistant layer comprises at least one of: amorphous carbon; a ceramic material, wherein the ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; an epoxide; an acrylate; an

acrylonitrile; a xylene; a styrene; polymerized monomers; polymerized oligomers; an organic polymer; an inorganic-organic polymer; and combinations thereof.

Claim 107 recites the article of Claim 42, wherein the adhesion layer comprises at least one of: amorphous carbon; a ceramic material, wherein the ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; an epoxide; an acrylate; an acrylonitrile; a xylene; a styrene; and combinations thereof.

VI. Issues

A. Whether Claims 1-2, 4-22, 26-38, 40-56, 58, and 104-107 are unpatentable under 35 U.S.C.§103(a) over Suzuki et al. (U.S. Patent 6,198,217) in view of Ikai et al. (U.S. Patent 6,015,951).

B. Whether Claims 6 and 42 are unpatentable under 35 U.S.C.§103(a) over Suzuki et al. and Ikai et al. and further in view of Kohara et al. (U.S. Patent 6,212,057).

VII. Grouping of Claims

Each claim is separately patentable as defining the invention differently.

VIII. Arguments

The Examiner rejected Claims 1-2, 4-22, 24, 26-38, 40-56, 58, and 104-107 under 35 U.S.C.§103(a) as being unpatentable over Suzuki et al. (U.S. Patent 6,198,217) in view of Ikai et al. (U.S. Patent 6,015,951). Claim 24 was canceled in Paper No. 6, filed on September 15, 2003, after the Final Office Action of August 16, 2003. The Examiner states that Suzuki et al. disclose an EL unit covered with "a protective *double* layer of an organic barrier layer and an inorganic barrier layer (emphasis added)."

The Examiner rejected Claims 6 and 42 under 35 U.S.C.§103(a) as being unpatentable over Suzuki et al. and Ikai et al. and further in view of Kohara et al. (U.S. Patent 6,212,057).

A. Suzuki et al. teach a double barrier layer in which an organic layer is disposed on an electroluminescent layer.

Suzuki et al. describe an electroluminescent device that is coated with a protective double layer. See Abstract. At column 2, lines 60-62, the reference describes a protective layer P comprising an organic barrier layer 20 and an inorganic barrier layer 22. As seen in both Figures 1 and 2, organic layer 20 is disposed on a surface of an electroluminescent unit U. Organic layer 22 is disposed between electroluminescent unit U and inorganic layer 22. Electroluminescent unit U comprises an anode 10, a hole transport layer 12, a light emitting layer 14, an electron transport layer 16, and a cathode 18. See column 2, lines 57-59, of the reference.

B. Ikai et al. teach a photoelectric transfer device comprising a cholesteric liquid crystalline polymer layer formed on a light transmitting substrate.

Ikai et al. disclose a photoelectric transfer device comprising a photoelectric transfer element, a cholesteric liquid crystalline polymer, and an ultraviolet cutoff layer. see column 2, lines 9-16. The cholesteric liquid is usually formed on a light transmitting substrate. The light transmitting substrate is a stretched sheet made a polymeric substance, including a polyimide, a polyethersulfone, a polyethylene terephthalate, a polyethylene naphthalate, and a polyacrylate. See column 26, lines 5-15. Ikai et al. do not disclose a moisture and oxygen-resistant barrier layer comprising an inorganic material disposed on the substrate.

C. Kohara et al. teach a flexible thin film capacitor having an adhesive layer.

Kohara et al. teach a flexible thin film capacitor comprising a substrate 1, metal electrode films 3, and an inorganic high dielectric film 4. The inorganic high dielectric film 4 is interposed between the metal electrode films 3. The inorganic high dielectric film 4 and at least one electrode film 3 are formed in contact with an adhesive film 2 on the substrate 1. The high dielectric film 4 is in partial contact with adhesive film 2. See column 2, lines 41-49; column 5, lines 30-38; and Figures 1-8. Adhesive film 2 contains at least one of Cr, NiCr, Ti, Co, Ge, Cu, Sn, Mo, and W. See column 2, lines 60-61.

More specifically, adhesive film 2 is one of the above-mentioned metals or a metal oxide comprising at least one oxide of these metals. See column 3, lines 59-67.

Kohara et al. do not disclose a moisture and oxygen-resistant barrier layer comprising an inorganic material disposed on the substrate.

D. Examiner's position.

In the July 18, 2003, Final Office Action (Paper No. 5), the Examiner states that Suzuki et al. disclose an electroluminescent unit covered with "a protective *double* layer of an organic barrier layer and an inorganic barrier layer (emphasis added)." The Examiner states that, whereas Suzuki et al. do not specify that the substrate be the polymer as claimed in Claims 1 and 24, Ikai et al. teaches that the device can be a transmitting substrate such as a plastic film of polyimide, polyether-sulfone, or polyethylence terephthalate. The Final Office Action combined these aspects of the cited references to arrive at the conclusion that Claims 1-2, 4-22, 24, 26-38, 40-56, 58, and 104-107 would have been obvious under 35 U.S.C. 103(a).

Regarding Claims 6 and 42, the Examiner states that, whereas Suzuki et al. and Ikai et al. do not disclose an adhesion layer comprising a metal in elemental form or metal compounds recited in Claims 6 and 42 of the present Application, Kohara et al. disclose an adhesive film containing at least one metal or metal oxide. The Final Office Action combined these aspects of the cited references to arrive at the conclusion that Claims 6 and 42 would have been obvious under 35 U.S.C. 103 (a).

E. Suzuki et al. and Ikai et al. neither teach nor suggest all teach all the aspects of the claimed invention.

In order to establish a *prima facie* case of obviousness, the references must teach or suggest all of the claimed limitations of the present invention. Accordingly, the combination of references cited by the Examiner fails to teach or suggest the limitation of a *single* barrier layer disposed on at least one surface of the polymeric substrate, wherein the barrier layer comprises an *inorganic material,* as recited in independent Claim 1, or at

least one of *a metal oxide, a metal nitride, a metal carbide, and combinations thereof,* as recited in independent Claims 26, and 37.

As noted by the Examiner, Suzuki et al. instead teach a *double* layer of an organic barrier layer and an inorganic barrier layer. The protective layer P of Suzuki et al. has an organic barrier layer 20 and an inorganic barrier layer 22, where organic layer 20 – *not* inorganic layer 22 – is disposed on the substrate 24. See Figures 1 and 2 and column 2, lines 59-62, of the reference. As previously noted, Ikai et al. as well do not teach a *single* barrier layer comprising an inorganic material disposed on at least one surface of the polymeric substrate, wherein the barrier layer comprises an inorganic material.

As the combination of Suzuki et al. with Ikai et al. neither teaches nor suggests all of the limitations of the claimed invention, the combination of these references is improper, and Claims 1, 2, 4-22, 26-38, 40-56, and 104-107 are therefore considered to be allowable.

F. Suzuki et al. teach away from the claimed invention.

A prior art reference must be considered in its entirety, including disclosures that lead away from the claimed invention. Accordingly, Suzuki et al. actually teach *away* form disposing a single barrier coating comprising an inorganic material.

The reference, in column 5, lines 41-46, teaches that moisture and air are adsorbed by electroluminescent unit U through pinholes or defects in cathode 18. To cover these defects, the reference teaches depositing an organic barrier layer 20 – rather than inorganic barrier layer 22 – to cover defects on electroluminescent unit U and to provide a smooth surface for deposition of inorganic layer 22. See column 5, lines 51-67. In addition, Suzuki et al. teach as deposition of a "double barrier layer" and thus teaches away from a single barrier layer comprising an *inorganic material* disposed on a surface of the polymeric substrate, as claimed in the present application.

Because Suzuki et al. teaches away form the claimed invention, the combination of the reference with Ikai et al., and in further view of Kohara et al., is improper. Claims 1, 2, 4-22, 26-38, 40-56, and 104-107 are therefore considered allowable.

G. Kohara et al.

The Examiner states that Claims 6 and 42 are unpatentable under 35 U.S.C. § 103 unpatentable over Suzuki et al. and Ikai et al. and further in view of Kohara et al. However, the shortcomings of the combination of Suzuki et al. in view of Ikai et al. are not cured by the further combination with Kohara et al. Thus, the combination of Suzuki et al. and Ikai et al. and further in view of Kohara et al. is improper. Claims 6 and 42 are therefore considered allowable.

H. Conclusion.

The Examiner's rejections of Claims 1, 2, 4-22, 26-38, 40-56, and 104-107 should be reversed.

Respectfully submitted,

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IX. Appendix of Claims

The appealed claims are as follows:

1. An article, said article comprising:

a) a polymeric substrate comprising one of a polycarbonate, a polyimide, a polyethersulfone, a polynorborene, a polyethylene terephthalate, a polyethylene naphthalate, a polyacrylate, and combinations thereof; and

b) a barrier layer disposed on at least one surface of said polymeric substrate, wherein said barrier layer comprises an inorganic material, and wherein said barrier layer has a thickness of less than 10,000 nm and is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day.

2. The article according to Claim 1, further including at least one layer, wherein said at least one layer is disposed on a surface of said barrier layer opposite said polymeric substrate, such that said barrier layer is interposed between said polymeric substrate and said at least one layer.

4. The article according to Claim 1, further including at least one layer interposed between said barrier layer and said polymeric substrate.

5. The article according to Claim 4, wherein said at least one layer comprises an adhesion layer for promoting adhesion of said barrier layer to said polymeric substrate.

6. The article according to Claim 5, wherein said adhesion layer comprises at least one of: a metal in elemental form, a carbide of said metal, an oxycarbide of said metal, an oxide of said metal, and a nitride of said metal, wherein said metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc,

tin, cadmium, tungsten, molybdenum, chromium, vanadium, platinum, and combinations thereof.

7. The article according to Claim 2, wherein said at least one layer comprises at least one of an abrasion resistant layer, an ultraviolet radiation-absorbing layer, an infrared radiation-reflecting layer, and an electrically conducting layer.

8. The article according to Claim 7, wherein said abrasion resistant layer comprises at least one of: a carbide of a metal, an oxycarbide of said metal, an oxide of said metal, and a nitride of said metal, wherein said metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, platinum, and combinations thereof.

9. The article according to Claim 7, wherein said ultraviolet radiation-absorbing layer comprises at least one of titanium oxide, zinc oxide, cerium oxide, a polymer, and combinations thereof.

10. The article according to Claim 7, wherein said infrared radiation-reflecting layer comprises at least one of silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

11. The article according to Claim 7, wherein said electrically conducting layer comprises at least one of silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

12. The article according to Claim 1, wherein said inorganic material comprises at least one of an oxide, a nitride, and a carbide of a metal, and combinations thereof.

13. The article according to Claim 12, wherein said metal is one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof.

14. The article according to Claim 13, wherein said transition metal is titanium.

15. The article according to Claim 13, wherein said inorganic material comprises titanium oxide.

16. The article according to Claim 13, wherein said inorganic material comprises silicon nitride.

17. The article according to Claim 1, wherein said barrier layer has a thickness in a range from about 10 nm to less than 10,000 nm.

18. The article according to Claim 17, wherein said barrier layer has a thickness in a range from about 20 nm to about 500 nm.

19. The article according to Claim 1, wherein said barrier layer has a water vapor transmission rate of up to about 0.2 g/m^2-day.

20. The article according to Claim 1, wherein said barrier layer has an oxygen transmission rate at 25°C and 100% oxygen concentration of up to about 0.2 cc/m^2-day.

21. The article according to Claim 1, wherein the article is one of a light emitting diode (LED), a liquid crystal display (LCD), a photovoltaic article, a flat panel display device, an electrochromic article, an organic integrated circuit, and an organic electroluminescent device (OELD).

22. The article according to Claim 1, wherein said barrier layer is deposited on said polymeric substrate by: injecting at least one reagent into an expanding thermal plasma; reacting said at least one reagent in said expanding thermal plasma to form at least one deposition precursor; and depositing said at least one deposition precursor on said polymeric substrate at a rate of at least about 200 nm/min to form said barrier layer on said polymeric substrate.

26. A barrier layer deposited on a polymeric substrate, said polymeric substrate comprising one of a polycarbonate, a polyimide, a polyethersulfone, a polynorborene, a polyethylene terephthalate, a polyethylene naphthalate, a polyacrylate, and combinations thereof, said barrier layer having a thickness of less than 10,000 nm

and comprising at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, and wherein each of said metal nitride, said metal carbide, and said metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof, and wherein said barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day.

27. The barrier layer according to Claim 26, wherein said transition metal is titanium.

28. The barrier layer according to Claim 26, wherein said barrier layer comprises titanium oxide.

29. The barrier layer according to Claim 26, wherein said barrier layer comprises silicon nitride.

30. The article according to Claim 26, wherein said barrier layer has a thickness in a range from about 10 nm to less than 10,000 nm.

31. The article according to Claim 30, wherein said barrier layer has a thickness in a range from about 20 nm to about 500 nm.

32. The barrier layer according to Claim 26, wherein said barrier layer has a water vapor transmission rate of up to about 0.2 g/m^2-day.

33. The barrier layer according to Claim 26, wherein said barrier layer has an oxygen transmission rate at 25°C and 100% oxygen concentration of up to about 0.2 cc/m^2-day.

34. The barrier layer according to Claim 26, wherein said barrier layer is deposited on said polymeric substrate by: injecting a first reagent into an expanding thermal plasma, said first reagent comprising at least one of silicon, aluminum, zinc,

indium, tin, a transition metal, and combinations thereof; injecting a second reagent into said expanding thermal plasma, the second reagent comprising at least one of oxygen, nitrogen, hydrogen, water, and ammonia; reacting said first reagent and said second reagent in said expanding thermal plasma to form at least one deposition precursor; and depositing said at least one deposition precursor on said polymeric substrate at a rate of at least about 200 nm/min to form said barrier layer on said polymeric substrate.

35. The barrier layer according to Claim 34, wherein the at least one deposition precursor is deposited at a rate of at least about 600 nm/min to form the barrier layer on said polymeric substrate.

36. The barrier layer according to Claim 34, wherein the at least one deposition precursor is deposited on said polymeric substrate at a rate of at least about 3,000 nm/min to form the barrier layer on said polymeric substrate.

37. An article, said article comprising:

a) a polymeric substrate comprising one of a polycarbonate, a polyimide, a polyethersulfone, a polynorborene, a polyethylene terephthalate, a polyethylene naphthalate, a polyacrylate, and combinations thereof; and

b) a barrier layer, wherein said barrier layer has a thickness of less than 10,000 nm and comprises at least one of a metal oxide, a metal nitride, a metal carbide, and combinations thereof, wherein each of said metal nitride, said metal carbide, and said metal oxide contains at least one of silicon, aluminum, zinc, indium, tin, a transition metal, and combinations thereof, and wherein said barrier layer is resistant to transmission of moisture and oxygen therethrough and has a water vapor transmission rate (WVTR) at 25°C and 100% relative humidity of less than about 2 g/m^2-day and an oxygen transmission rate (OTR) at 25°C and 100% oxygen concentration of less than about 2 cc/m^2-day.

38. The article according to Claim 37, further including at least one layer, wherein said at least one layer is disposed on a surface of said barrier layer opposite said

polymeric substrate, such that said barrier layer is interposed between said polymeric substrate and said at least one layer.

40. The article according to Claim 37, further including at least one layer interposed between said barrier layer and said polymeric substrate.

41. The article according to Claim 40, wherein said at least one layer comprises an adhesion layer for promoting adhesion of said barrier layer to said polymeric substrate.

42. The article according to Claim 41, wherein said adhesion layer comprises at least one of: a metal in elemental form, a carbide of said metal, an oxycarbide of said metal, an oxide of said metal, and a nitride of said metal, wherein said metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, platinum, and combinations thereof.

43. The article according to Claim 38, wherein said at least one layer comprises at least one of an abrasion resistant layer, an ultraviolet radiation-absorbing layer, infrared radiation-reflecting layer, and an electrically conducting layer.

44. The article according to Claim 43, wherein said abrasion resistant layer comprises at least one of: a carbide of a metal, an oxycarbide of said metal, an oxide of said metal, and a nitride of said metal, wherein said metal is one of silicon, aluminum, titanium, zirconium, hafnium, tantalum, gallium, germanium, zinc, tin, cadmium, tungsten, molybdenum, chromium, vanadium, platinum, and combinations thereof.

45. The article according to Claim 43, wherein said ultraviolet radiation-absorbing layer comprises at least one of titanium oxide, zinc oxide, cerium oxide, a polymer, and combinations thereof.

46. The article according to Claim 43, wherein said infrared radiation-reflecting layer comprises silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

47. The article according to Claim 43, wherein said electrically conducting layer comprises silver, aluminum, indium, tin, indium tin oxide, cadmium stannate, zinc, and combinations thereof.

48. The article according to Claim 37, wherein said transition metal is titanium.

49. The article according to Claim 48, wherein said barrier layer comprises titanium oxide.

50. The article according to Claim 37, wherein said barrier layer comprises silicon nitride.

51. The article according to Claim 37, wherein said barrier layer has a thickness in a range from about 10 nm to less than 10,000 nm.

52. The article according to Claim 51, wherein said barrier layer has a thickness in a range from about 20 nm to about 500 nm.

53. The article according to Claim 37, wherein said barrier layer has a water vapor transmission rate of up to about 0.2 g/m^2-day.

54. The article according to Claim 37, wherein said barrier layer has an oxygen transmission rate at 25°C and 100% oxygen concentration of up to about 0.2 cc/m^2-day.

55. The article according to Claim 37, wherein the article is one of a light emitting diode (LED), a liquid crystal display (LCD), a photovoltaic article, a flat panel display device, an electrochromic article, an organic integrated circuit, and an organic electroluminescent device (OELD).

56. The article according to Claim 37, wherein said barrier layer is deposited on said polymeric substrate by: injecting a first reagent into an expanding thermal plasma, said first reagent comprising at least one of silicon, aluminum, zinc, indium, tin,

a transition metal, and combinations thereof; injecting a second reagent into said expanding thermal plasma, the second reagent comprising at least one of oxygen, nitrogen, and ammonia; reacting said first reagent and said second reagent in said expanding thermal plasma to form at least one deposition precursor; and depositing said at least one deposition precursor on said polymeric substrate at a rate of at least about 200 nm/min to form said barrier layer on said polymeric substrate.

104. The article according to Claim 6, wherein said adhesion layer comprises at least one of: amorphous carbon; a ceramic material, wherein said ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; an epoxide; an acrylate; an acrylonitrile; a xylene; a styrene; and combinations thereof.

105. The article according to Claim 8, wherein said abrasion resistant layer comprises at least one of: amorphous carbon; a ceramic material, wherein said ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; an epoxide; an acrylate; an acrylonitrile; a xylene; a styrene; polymerized monomers; polymerized oligomers; an organic polymer; an inorganic-organic polymer; and combinations thereof.

106. The article according to Claim 44, wherein said abrasion resistant layer comprises at least one of: amorphous carbon; a ceramic material, wherein said ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; an epoxide; an acrylate; an acrylonitrile; a xylene; a styrene; polymerized monomers; polymerized oligomers; an organic polymer; an inorganic-organic polymer; and combinations thereof.

107. The article according to Claim 42, wherein said adhesion layer comprises at least one of: amorphous carbon; a ceramic material, wherein said ceramic material comprises at least one of glass, silica, alumina, zirconia, boron nitride, boron carbide, and boron carbonitride; a silicone; a siloxane; an epoxide; an acrylate; an acrylonitrile; a xylene; a styrene; and combinations thereof.